

to the plane of reflection, when the suspended particles became finer, and therefore the beam more nearly continuous."

Through the courtesy of its owner, I have been permitted to see and to experiment with the piece of plate glass above referred to. Placed in front of the electric lamp, whether edgewise or transversely, it discharges bluish polarized light laterally, the colour being by no means a bad imitation of the blue of the sky.

Prof. Stokes considers that this deportment may be invoked to decide the question of the direction of the vibrations of polarized light. On this point I would say, if it can be demonstrated that when the particles are small in comparison to the length of a wave of light, the vibrations of a ray reflected by such particles cannot be perpendicular to the vibrations of the incident light; then assuredly the experiments recorded in the foregoing communication decide the question in favour of Fresnel's assumption.

As stated above, almost all liquids have motes in them sufficiently numerous to polarize sensibly the light, and very beautiful effects may be obtained by simple artificial devices. When, for example, a cell of distilled water is placed in front of the electric lamp, and a slice of the beam permitted to pass through it, scarcely any polarized light is discharged, and scarcely any colour produced with a plate of selenite. But while the beam is passing through it, if a bit of soap be agitated in the water above the beam, the moment the infinitesimal particles reach the beam the liquid sends forth laterally almost perfectly polarized light; and if the selenite be employed, vivid colours flash into existence. A still more brilliant result is obtained with mastic dissolved in a great excess of alcohol.

The selenite rings constitute an extremely delicate test as to the quantity of motes in a liquid. Commencing with distilled water, for example, a thickish beam of light is necessary to make the polarization of its motes sensible. A much thinner beam suffices for common water; while with Brücke's precipitated mastic, a beam too thin to produce any sensible effect with most other liquids, suffices to bring out vividly the selenite colours.

January 21, 1869.

JOHN PETER GASSIOT, Esq., Vice-President, in the Chair.

The Chairman stated that Sir John Macneill and Mr. Edward Solly, who, by reason of non-payment of their annual contributions, ceased to be Fellows of the Society at the last Anniversary, had applied for readmission. Extracts from their letters, explaining the circumstances under which non-payment had occurred, were read, and notice was given that the question of their readmission would be put to the vote at the next Meeting.

The following communications were read :—

I. "On the Thermal Resistance of Liquids." By FREDERICK GUTHRIE, F.C.S. Communicated by Dr. TYNDALL. Received October 16, 1868.

(Abstract.)

The memoir of which the following is an abstract gives an account of some experiments made by the author with the object of determining the laws according to which heat travels by conduction through liquids.

After pointing out the importance of the subject, and briefly recapitulating the methods previously used and the results obtained by other experimenters, the "Diathermometer" is described.

This instrument, which may be employed for the examination of the thermal resistance or conducting power of solids as well as liquids, has the following form. A hollow brass cone, having a platinum base, is screwed with its apex downwards into a tripod-stand which rests upon adjusting screws. The apex of the cone is tubular, and carries a cock, through which passes a vertical glass tube graduated and dipping into water. The level of the water in the tube is nearly as high as the apex of the cone. By means of a micrometer screw, a second cone, exactly similar and equal to the first, having its apex upwards, may be brought to any required distance from the lower cone. The brass cones and their platinum faces are highly polished, and the latter are cleaned by washing successively with hot nitric acid, caustic soda, alcohol, and water. The upper surface of the lower cone is brought into an exactly horizontal position, and the upper cone is lowered to any required distance from it. There is thus formed between the platinum faces a cylindrical interval of known height or thickness and diameter, and having its opposite faces parallel and horizontal. This wall-less chamber receives the liquid whose thermal resistance has to be measured. A liquid, introduced by means of a strangulated pipette of known capacity (equal, say, to the interstitial space when the cone-faces are 1 millim. apart) between the cones, remains there by means of its adhesion and cohesion. A description is given of the method used to get a constant current of water of uniform and known temperature to pass through the upper cone. When such a current passes, the platinum face of the upper cone becomes heated; it communicates its heat to the liquid in contact with it. The heat passes downwards through the liquid, heats the upper surface of the lower cone, expands the air therein, and depresses the level of the water in the tube attached to the lower cone.

A description is given of the most prominent sources of error of this instrument, and the means which were employed to eliminate them. It is concluded, from direct experiments (1st, by measuring the time required for the production of the first heat-effect in the lower cone; 2ndly, by showing the smallness of the difference caused by the introduction of athermanous disks), and from comparison with recent results of Magnus, that the effect of radiation in all the cases tried is negligible if not nothing.

By measuring resistance rather than conductivity, several sources of

experimental error are eliminated. If the two cones are brought into actual contact, and water of a known temperature is led for a given time through the upper cone, a certain thermal effect is produced in the lower one. If the cones be then separated, and a liquid be interposed between them, and if water of the same temperature as before be led for the same time as before through the upper cone, a less thermal effect is produced. *The difference between the two effects is a measure of the resistance of the liquid.* Results so obtained have to be corrected for the varying pressure to which the air in the lower cone is subjected as the water in the glass tube sinks. To find the absolute results in thermal units, we have to take into account the diameter of the surface of the lower cone, its capacity, and the specific heat of the air which is in it.

The following are the chief results obtained:—

(1) The connexion in the instance of water between the thickness and the time required for the first-heat effect.

(2) The connexion between the temperature and the time required for the first-heat effect. It is shown that hotter water conducts heat better than colder; and that the hotter the conducting-water, the greater is the difference in rate.

(3) The connexion between the entire quantity of heat passing in a given time and the thickness and temperature of the conducting-water.

(4) The effect of the solution of various salts in altering the thermal resistance of water. Every salt tried was found, when dissolved in water, to increase its thermal resistance. The author submits that the effect of the dissolved salt is chiefly, perhaps wholly, due to the displacement of a portion of the water by a substance having greater resistance, and to the modification in the specific heat of the liquid, caused by the introduction of the salt.

(5) The resistance of the liquids in the following list was examined under precisely similar circumstances. The thickness was in each case 1 millim. The initial temperature of the liquid was $20^{\circ}17\text{C}.$, and the temperature-difference, ΔT , was $10^{\circ}\text{C}.$ That is, the platinum surface of the upper cone was maintained at $30^{\circ}17\text{C}.$ The duration of the experiment in each case was 1'. The numbers show the specific resistance under the above circumstances, that is, the ratio between the quantities of heat arrested by the several liquids and that arrested by water.

Liquid.	Specific resistance.	Liquid.	Specific resistance.
Water	1.	Acetate of amyl	10.00
Glycerine.....	3.84	Amylamin	10.14
Acetic acid (glacial)	8.38	Amylic alcohol	10.23
Acetone	8.51	Oil of turpentine	11.75
Oxalate of ethyl	8.85	Nitrate of butyl	11.87
Sperm-oil	8.85	Chloroform	12.10
Alcohol	9.08	Bichloride of carbon	12.92
Acetate of ethyl	9.08	Mercury amyl	12.92
Nitrobenzol.....	9.86	Bromide of ethylen	13.16
Oxalate of amyl	10.06	Iodide of amyl	13.27
Butylic alcohol	10.00	Iodide of ethyl (?)	?

The more salient points of these results are pointed out, such as the preeminently small resistance of water and of bodies containing a large proportion of the elements of water (potential water); the possible connexion of this fact with the results of Magnus concerning the conductivity of hydrogen; the increased resistance accompanying increased molecular complexity in the case of isotypic liquids, as exemplified by the alcohols and their derivatives: the great resistance shown by the liquids containing halogens. The results obtained by Tyndall in regard to relative diathermancy are shown to be in accord with the author's results concerning resistance. *A highly diathermanous liquid invariably offers great resistance to conducted heat.* The relation between electrical and thermal resistance in the case of liquids is also briefly discussed.

II. "Results of a preliminary Comparison of certain Curves of the Kew and Stonyhurst Declination Magnetographs." By the Rev. W. SIDGREAVES and BALFOUR STEWART, LL.D., F.R.S. Received October 28, 1868.

The observatories of Kew and Stonyhurst are not far apart, both being in England; the first in the county of Surrey (Lat. $51^{\circ} 28' 6''$ N., Long. $0^{\circ} 18' 47''$ W.), and the second in the county of Lancashire (Lat. $53^{\circ} 50' 40''$ N., Long. $2^{\circ} 28' 10'' \cdot 2$ W.).

If we bear in mind (as a fact well proved, chiefly by the researches of General Sabine) that magnetic disturbances are of a cosmical nature, we cannot evidently expect any considerable difference between these two stations, and it might be very naturally supposed that the magnetic variations should be precisely the same in each.

This is no doubt approximately true, but nevertheless there is on certain occasions a residual difference between the indications of the two places, and one which is caught by the eye from the automatic records with very great ease, inasmuch as the instrumental time-scale of these is precisely the same for both places; and not only is the time-scale the same, but *for slow disturbances* the vertical spaces traversed by the traces are the same for both declination magnetographs.

We venture to bring before the Royal Society certain results of an inter-comparison of the declination curves of these two observatories, although only of a preliminary nature, because the subject is one of much interest, and because these results appear to exhibit, superposed upon a disturbance which is mainly cosmical, a comparatively small effect, which appears to be more of a local nature, but which is not unworthy of investigation.

The records which we have investigated are represented graphically in Plates III. and IV.; and in them the disturbances which have been measured are denoted by figures attached to their extremities.

The following Table exhibits the results of these measurements:—